AD-A151 072 ACTIVE MAGNETOSPHERIC PARTICLE TRACING EXPLORERS (AMPTE)(U) IOWA UNIV IOWA CITY R R ANDERSON 07 FEB 85 N00014-82-K-0183 1/1

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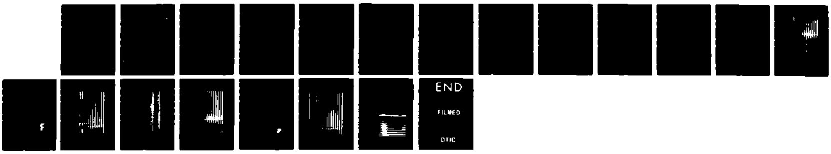

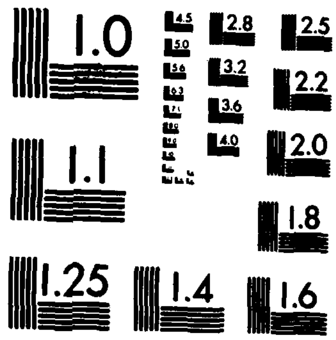

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(12)

Title: Active Magnetospheric Particle Tracing Explorers (AMPTE)

Annual Letter Report for ONR Contract N00014-82-K-0183
Covering the Time Period 1 December 1983 to 30 November 1984

INTRODUCTION

The primary purposes of the Active Magnetospheric Particle Tracing Explorers (AMPTE) program are (1) to carry out the release and monitoring of lithium and barium ions in the solar wind and within the distant magnetosphere in order to study the access of solar wind ions to the magnetosphere, the convective-diffusive transport and energization of magnetospheric particles, and the instabilities and wave-particle interactions associated with the releases and the subsequent evolution of the injected clouds, and (2) to generate massive releases of barium in the dawn magnetosheath in order to create visible artificial comets in the flowing solar wind plasma within which studies of diamagnetic effects, ionization, momentum exchange, ion transport, and visible phenomena can be made. A complete description of the AMPTE program is contained in the November 9, 1982, volume of EOS, Transactions of the American Geophysical Union, Vol. 63, No. 45, pages 843-850. Complete descriptions of the three spacecraft involved in the AMPTE program, the Charge Composition Explorer (CCE), the Ion Release Module(IRM), and the United Kingdom Subsatellite (UKS) and the experiments on the spacecraft will be included in the May 1985 issue of IEEE Transactions on Geoscience and Remote Sensing. The AMPTE program is a collaborative effort involving the United States, the Federal Republic of Germany, and the United Kingdom. Additional keywords: AMPTE Project, plasma waves, measuring instruments.

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Gerhard Haerendel of the Max-Planck-Institut fur Extraterrestrische Physik (MPE) in Garching bei Munchen, West Germany, principal investigator for the IRM, invited D. A. Gurnett and R. R. Anderson from the University of Iowa to be co-investigators on the IRM plasma wave team. A proposal for the University of Iowa's participation in the AMPTE project was submitted to the Office of Naval Research and subsequently funded under contract N00014-82-K-0183.

The AMPTE Mission was successfully launched on August 16, 1984, on a Delta launch vehicle. The University of Iowa hardware on the IRM was turned and the antennas were deployed on August 19, 1984. The instrumentation was checked out and observed to be fully operational. Two solar wind lithium ion releases were carried out on September 11 and September 20, 1984, and both releases were observed by our instrumentation which also provided data used to characterize conditions in the solar wind prior to the releases. A summary of our effort over the past year in preparing and testing our AMPTE-IRM Plasma Wave Experiment instrumentation and in supporting in-flight operations and data analysis follows.

INSTRUMENTATION

A block diagram of the University of Iowa AMPTE-IRM Plasma Wave Experiment instrumentation is shown in Figure 1. The University of Iowa provided all of the hardware indicated in the block diagram with the exception of the Fairchild Antenna (originally designed for the University of Iowa Hawkeye spacecraft) which was purchased by MPE. The hardware provided includes the following:

1. One modified spare instrument previously built for the HELIOS Mission, including ground support equipment.
2. One instrument developed for AMPTE consisting of a High Frequency Receiver, a Wideband Analog Receiver, and a Power Supply, including ground support equipment for this instrument.
3. A preamplifier housing containing preamplifiers for both instruments listed above, antenna control electronics, and provision for mounting instrument on the AMPTE-IRM spacecraft.

TESTING, CALIBRATION, AND PRE-LAUNCH ACTIVITIES

In December 1983, University of Iowa personnel continued the testing of the joint University of Iowa-Aerospace-MPE AMPTE-IRM Plasma Wave Experiment and spacecraft integration begun in November 1983 and reported on in the last annual report. A number of problems in the MPE spacecraft hardware were discovered by our testing and subsequently corrected during the testing. These included intermittent shorted wires in the harness and bad chips in the multiplexer and interface units. Numerous software problems in the programming of the microprocessor were alo identified and corrected. A successful full extension test of the Fairchild electric field antenna was carried out. The newly designed spacecraft power switches were also successfully tested. An abbreviated temperature test of the entire Plasma Wave Experiment was also conducted. All parts of the University of Iowa instrumentation operated correctly. However, another chip failed in the MPE multiplexer and the temperature test could not be completed. Test procedures were prepared to enable the MPE personnel to continue the testing after the University of Iowa personnel had returned to Iowa.

In March 1984 University of Iowa personnel returned to Munchen to participate in the spacecraft level EMC-RFI testing and to conduct a full checkout of our instrumentation following the spacecraft solar-simulation and vibration tests. The spacecraft was found to be very quiet with regard to electric field noise. However, the MPE search coil magnetometer detected a great deal of noise in addition to the expected power line harmonics normally expected. The University of Iowa Wideband Analog Receiver was used to attempt to identify the spectral features of this interference. By command the Plasma Wave Experiment microprocessor can select as input to the Wideband Analog Receiver signals from either the Fairchild electric field antenna or the search coil magnetometer. All parts of the University of Iowa instrumentation were found to be operating correctly. Calibration of our instrumentation was performed using the complete spacecraft data system and ground data handling system. This allowed us to have a computer compatible permanent record of the calibrations and to have data tapes to use in developing our data reduction and analysis programs. A significant problem identified during the testing was that the spacecraft sun sensors were located where they could receive reflections from the extended Fairchild electric antenna and where they could also be shadowed by the antenna. After the testing was completed, the location of the sun sensors was changed to avoid the serious problem.

In July 1984 University of Iowa personnel conducted final experiment checkouts and calibration at Kennedy Space Center, Florida. During these tests we detected a new failure in the MPE interface unit. Subsequently, a broken chip was found and replaced. Our instrumentation was found to be operating properly.

LAUNCH AND IN-ORBIT OPERATIONS

The AMPTE launch was orignally scheduled for August 9, 1984, but a failure in a ground computer system at the German Space Operations Center (GSOC) in Oberpfaffenhofen, West Germany, caused a delay. During this delay a malfunction in the air-conditioning system for the Delta shroud couased strips of aluminized Mylar to be blown inside the shroud onto the three spacecraft. This caused another delay because the shroud had to be removed, the spacecraft cleaned, and all of the sensors inspected. The three AMPTE spacecraft were finally successfully laughed together on a Delta 3924 launch vehicle from Kennedy Space Center on August 16, 1984. All three spacecraft were subsequently injected into their desired orbits by kick motors. The University of Iowa instrumentation on the IRM was turned on and the Fairchild electric field antennas were successfully deployed on August 19, 1984. Our instrumentation was checked out and found to be fully operational.

RELEASE OPERATIONS AND DATA REDUCTION AND ANALYSIS

During the year, University of Iowa personnel participated in AMPTE Science Working Group meetings and AMPTE-IRM Plasma Wave Team meetings to help plan continuing AMPTE operations (with regard to both the spacecraft and the ground data handling system) and to discuss the scientific results. In September 1984 University of Iowa personnel participated in the AMPTE solar wind lithium release operations at MPE and at GSOC. Analysis of the data from the AMPTE-IRM Plasma Wave Experiment was used to help characterize the conditions in the solar wind prior to the releases. Two solar wind

lithium releases were carried out, one on September 11 and the second on September 20, 1984. Data from the University of Iowa Plasma Wave Experiment instrumentation provided the first indications that the releases were accomplished (see Figures 2, 4, 6, and 8). An abrupt pulse of low frequency electrostatic noise followed by a sudden decrease in amplitudes at almost all frequencies were observed. Inside the diamagnetic cavity created by the release (see Figures 3 and 7 for the magnetic field profile) emissions believed to be associated with the lithium ion plasma frequency as well as yet unidentified emissions were generated. A large variety of plasma wave turbulence was observed for several minutes after the releases. Both electrostatic and electromagnetic waves were generated in the disturbed period as the magnetic field strongly returned and fluctuated. Extremely intense electrostatic waves similar to those observed at the earth's bow shock were observed when the lithium number density dropped to near the ambient solar wind ion number density. Plasma wave observations during the releases provided useful and exciting measurements of the electron number density in the ion cloud. The High Frequency Receiver, flown for the first time on AMPTE, produced spectacular data across its entire frequency range (100 kHz to 5.6 MHz) from which the efficiency of the release as well as the time history of the number density could be determined. Wideband Analog Receiver data of excellent quality was acquired during the releases (see Figures 5 and 9). So far we have been able with the wideband data to identify several instabilities or emissions associated with the releases such as ion plasma frequency emissions, chorus, electron cyclotron harmonic emissions, and doppler shifted ion acoustic waves. Although no positive indication of detection of release-produced lithium ions was made by the CCE

experiments, the releases must be considered extremely successful with regard to the studies of instabilities and wave-particle interactions associated with the releases. We are eagerly awaiting the remaining six releases in anticipation that the data from them will be as interesting as the data from the first two releases.

Following the releases and the acquisition of the first real master data record tapes, University of Iowa personnel continued working on the computer programs required to display the University of Iowa Plasma Wave Experiment data to facilitate its analysis and its comparison with other IRM experiments' data. Already four scientific papers are in preparation from the plasma wave team using the data from the first two releases. At this time we have received only two data tapes containing a total of less than twelve hours' worth of data. We are anxiously awaiting the regular flow of data tapes. The data we have seen so far show that the AMPTE-IRM Plasma Wave, Plasma, and Magnetometer Experiments' data sets will be extremely useful for studying wave-particle interaction processes in the magnetosphere even when active release experiments are not being carried out. An especially exciting possibility is the study of magnetospheric boundary phenomena using four spacecraft, ISEE 1, ISEE 2, AMPTE-IRM, and AMPTE-UKS. Because of the exceedingly good quality of the instrumentation on AMPTE-IRM (even though it came from many different groups and projects and some of it was quite old) and the resultant very useful data, it is quite evident that we will desire to process much more of the data than we had originally anticipated. To keep costs to a minimum, we are processing only the University of Iowa Plasma Wave Experiment data and not the Aerospace or MPE Plasma Wave data. We will share our processed data with the other Plasma Wave Team members and they have agreed to do the same with us.

PUBLICATIONS

The following publications which either have been completed or are nearing completion involve the AMPTE-IRM Plasma Wave Experiment and the efforts supported by ONR Contract N00014-82-K-0183

(1) The Plasma Wave Instrument Onboard the AMPTE-IRM Satellite.
B. HÄUSLER, R. R. ANDERSON, D. A. GURNETT, H. C. KOONS, R. H. HOLZWORTH, O. H. BAUER, R. TREUMANN, K. GNAIGER, D. ODEM, W. B. HARBRIDGE, AND F. EBERL.
To appear in the May 1985 issue of IEEE Transactions on Geoscience and Remote Sensing.

(2) Plasma Waves Observed by the IRM and UKS Spacecraft During the AMPTE Solar Wind Lithium Releases: Overview.
B. HÄUSLER, R. H. HOLZWORTH, L. J. WOOLLISCHOFT, R. R. ANDERSON, D. A. GURNETT, H. C. KOONS, O. H. BAUER, G. HAERENDEL, R. A. TREUMANN, H. LÜHR, P. J. CHRISTIANSEN, A. G. DARBYSHIRE, M. P. GOUGH, S. R. JONES, N. KLÖCKER, A. J. NORRIS, G. PASCHMANN, AND A. VALENZUELA.
Submitted to J. Geophys. Res., 1985.

(3) Electron Number Density From the AMPTE-IRM Plasma Wave Experiment During Solar Wind Lithium Releases.
R. R. ANDERSON, D. A. GURNETT, B. HÄUSLER, H. C. KOONS, R. H. HOLZWORTH, R. A. TREUMANN, O. H. BAUER, G. HAERENDEL, H. LÜHR, L. J. WOOLLISCROFT, AND M. P. GOUGH.
Submitted to J. Geophys. Res., 1985.

(4) Electrostatic Noise Associated With the AMPTE Solar Wind Lithium Releases: Analysis and Interpretation.
D. A. GURNETT, T. Z. MA, R. R. ANDERSON, O. H. BAUER, G. HAERENDEL, B. HÄUSLER, G. PASCHMANN, R. A. TREUMANN, H. C. KOONS, R. H. HOLZWORTH, AND H. LÜHR.
Submitted to J. Geophys. Res., 1985.

(5) Electron-Cyclogron Harmonic Waves Excited by a Lithium Release in the Solar Wind on AMPTE-IRM.
H. C. KOONS, B. HÄUSLER, R. R. ANDERSON, D. A. GURNETT, R. H. HOLZWORTH, O. H. BAUER, AND R. A. TREUMANN.
Submitted to J. Geophys. Res., 1985.

FIGURE CAPTIONS

Figure 1. Block diagram of the University of Iowa AMPTE-IRM Plasma Wave Experiment Instrumentation.

Figure 2. A one minute plot of the MRF (aka HELIOS) shock data for the first solar wind lithium release on September 11, 1984. The diamagnetic cavity lasted from about 07:25:03.7 to 07:25:15 (see Figures 3 and 5). Full scale for each channel is about 100 dB above the receiver noise level. The more prominent plasma wave features are described in the text.

Figure 3. A one minute plot of the electron gyrofrequency determined by the TUB AMPTE-IRM Magnetometer Experiment for the same time period as Figure 2.

Figure 4. A ten minute plot of the MFR Peak and Average data from 07:24:00 to 07:34:00 on September 11, 1984. The first solar wind lithium release occrred at 07:25:00. Note how long the effects of the release last.

Figure 5. AMPTE-IRM Magnetometer and Plasma Wave Experiment Wideband Analog Receiver data for the same time period as Figures 2 and 3.

Figure 6. A one minute plot of the MRF shock data for the second solar wind lithium release on September 20, 1984. The diamagnetic cavity lasted from about 09:56:01.7 to 09:56:09 (see Figures 7 and 9). Full scale for each channel is about 100 dB above the receiver noise level. The more prominent plasma wave features are described in the text.

Figure 7. A one minute plot of the electron gyrofrequency determined by the TUB AMPTE-IRM Magnetometer Experiment for the same time period as Figure 6.

Figure 8. A ten minute plot of the MFR Peak and Average data from 09:55:00 to 10:05:00 on September 20, 1984. The second solar wind lithium release occurred at 09:56:00. Note how long the effects of the release last.

Figure 9. Middle Panels: AMPTE-IRM Magnetometer and Plasma Wave Experiment Wideband Analog Receiver data for the same time period as Figures 6 and 7. The top panel shows the number density derived from the High Frequency Receiver plasma wave data. The bottom panel shows the data from the lower 11 channels of the MFR.

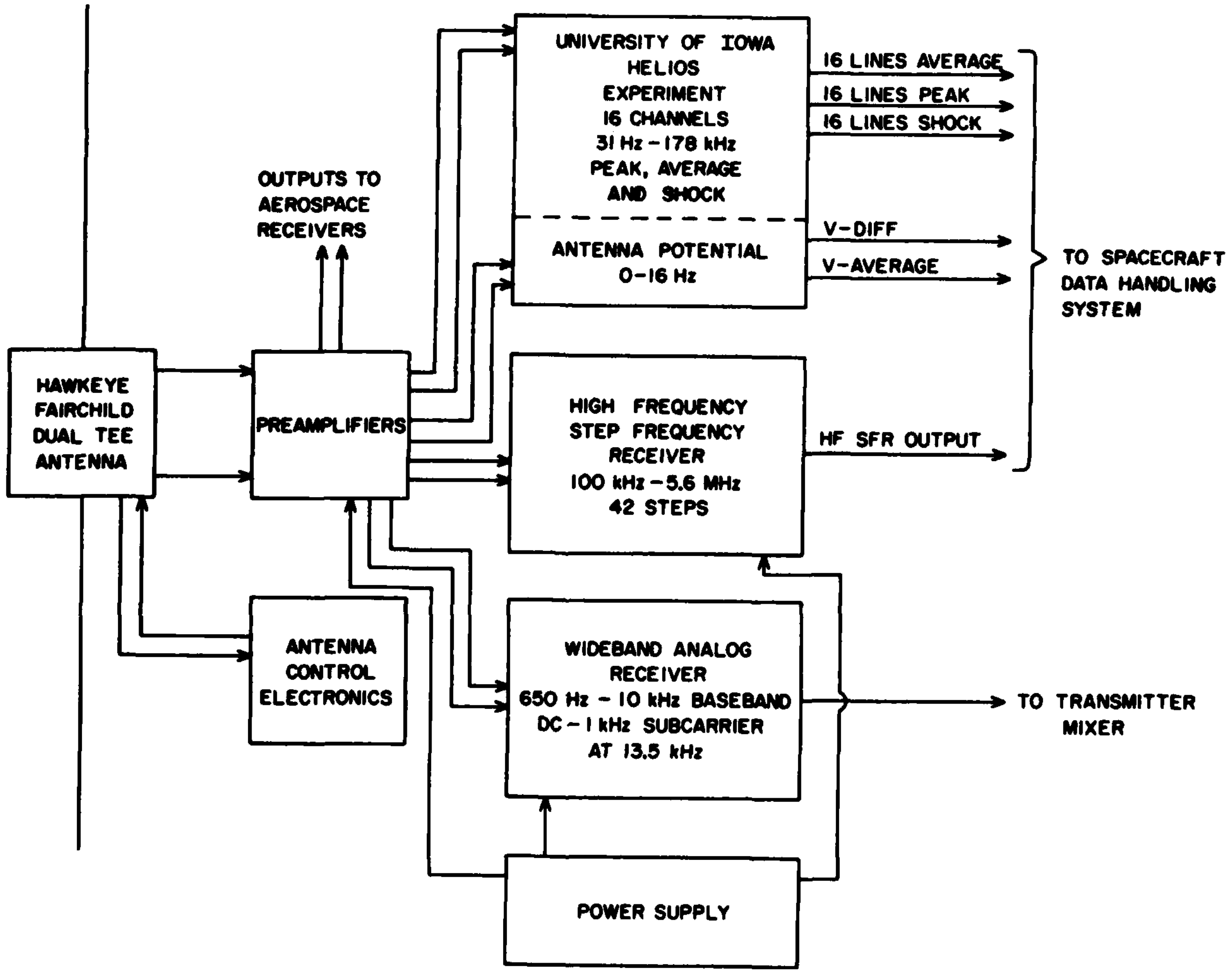
Submitted by:

R. R. Anderson /jh

Roger R. Anderson
February 7, 1985

C-G81-427

UNIVERSITY OF IOWA AMPTE IRM PLASMA WAVE EXPERIMENT



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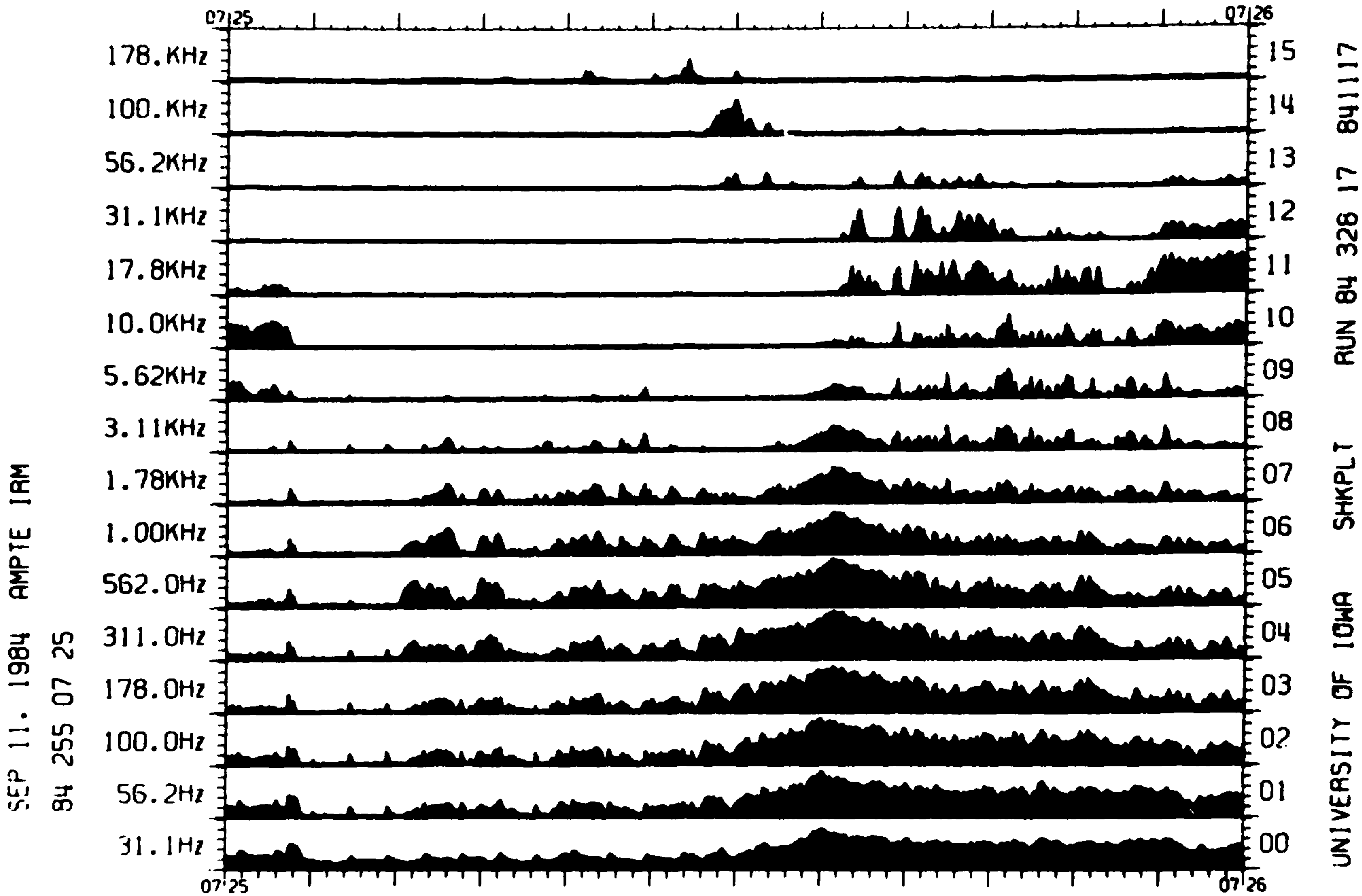
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1.00KHz
562.0Hz
311.0Hz
178.0Hz
100.0Hz
56.2Hz
31.1Hz
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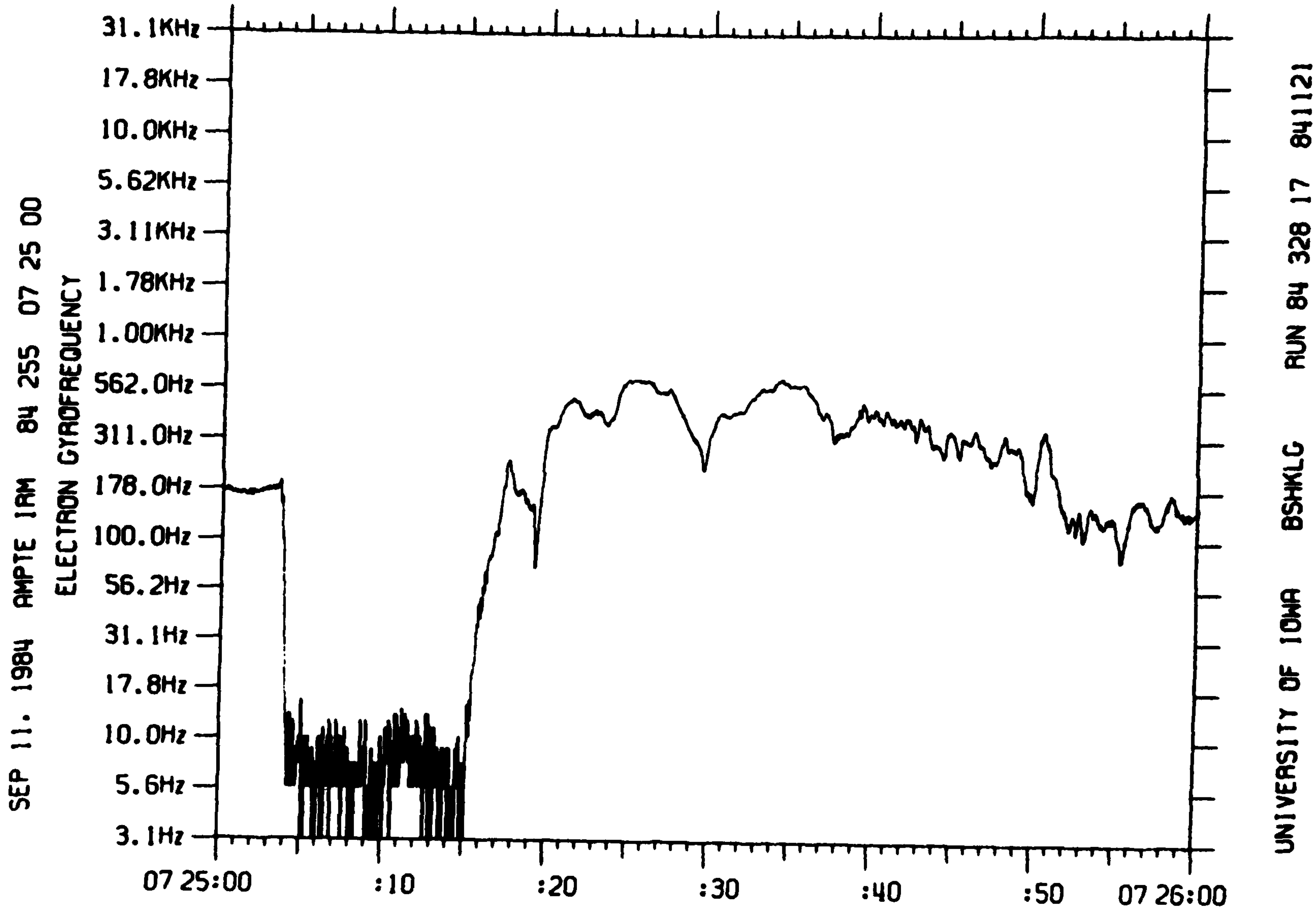
SHKPLT
UNIVERSITY OF IOWA

Figure 2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1.00KHz
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311.0Hz
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31.1Hz
17.8Hz
10.0Hz
5.6Hz
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UNIVERSITY OF IOWA BSHKLG RUN 84 328 17 841121

Figure 3

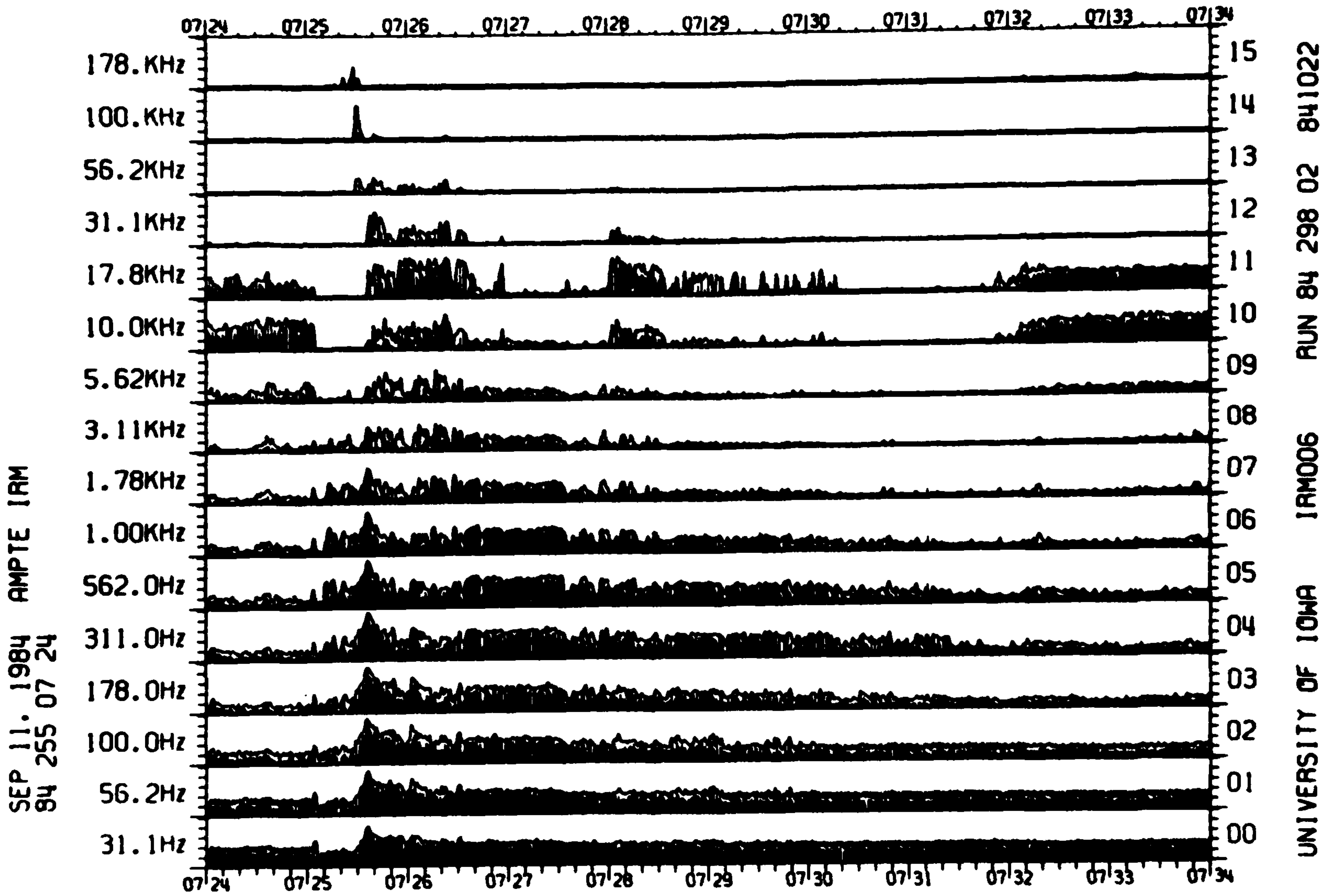

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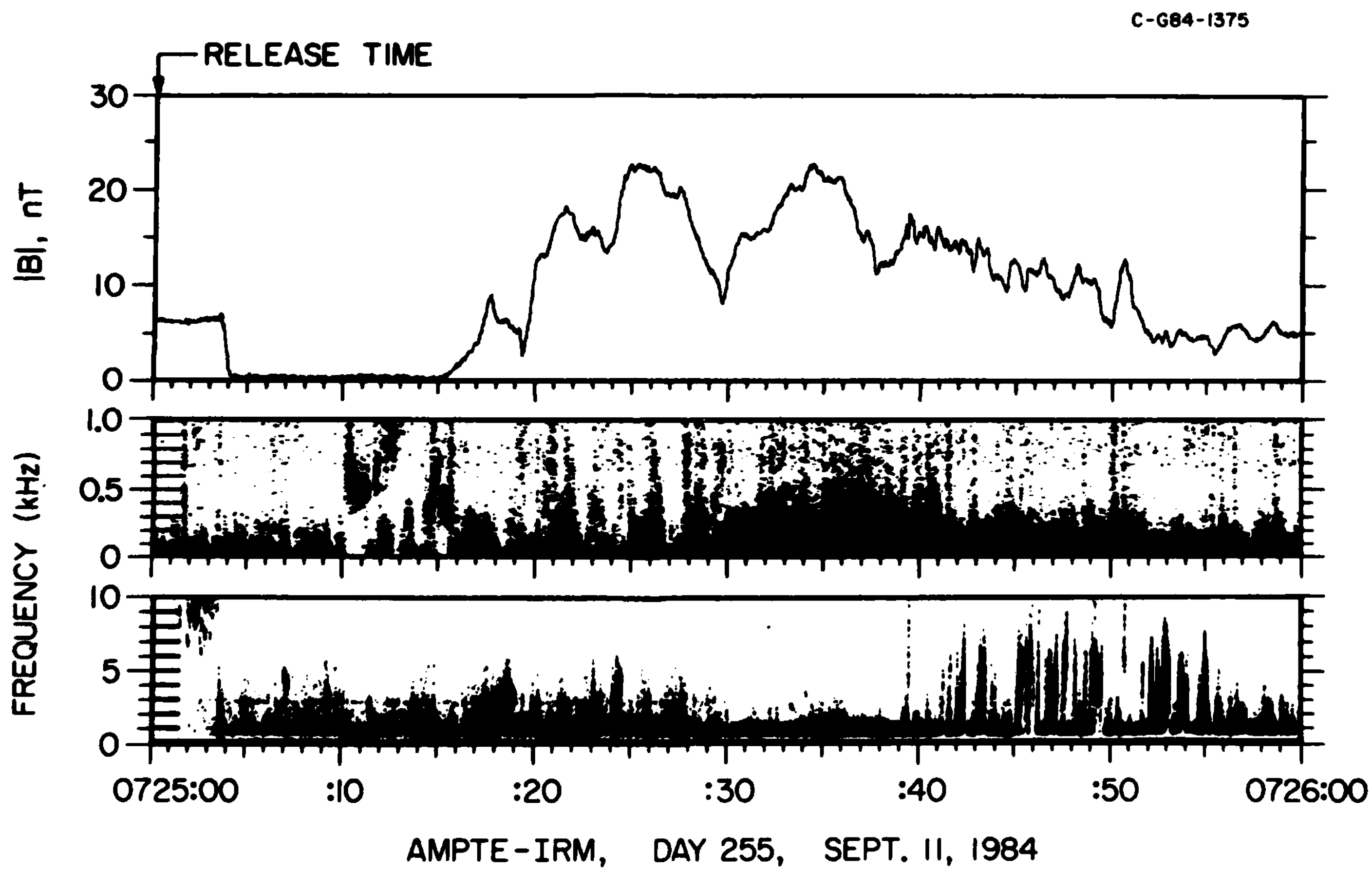
Figure 4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:10
:20
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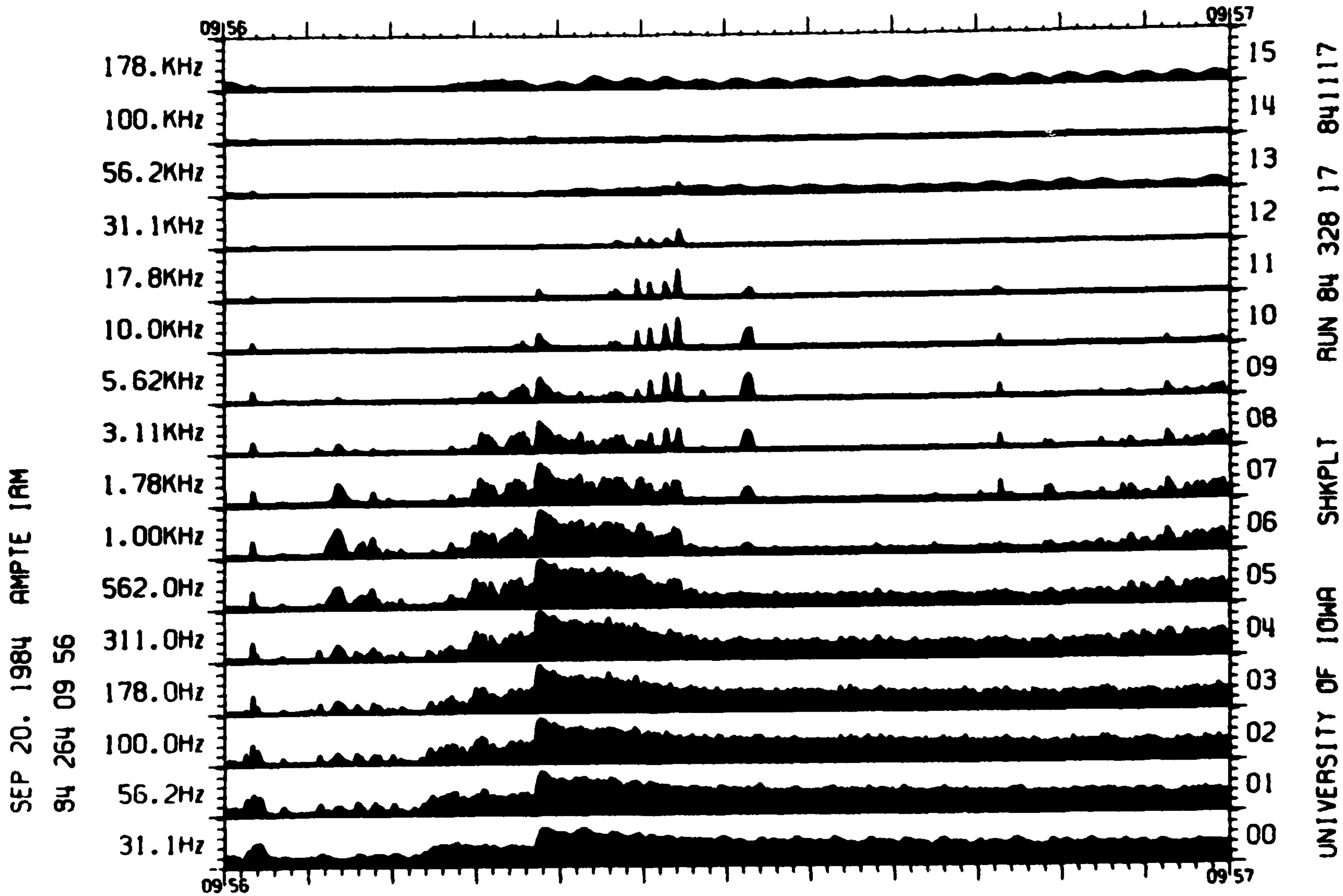
AMPTE-IRM, DAY 255, SEPT. 11, 1984

Figure 5



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3.11KHz
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1.00KHz
562.0Hz
311.0Hz
178.0Hz
100.0Hz
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31.1Hz
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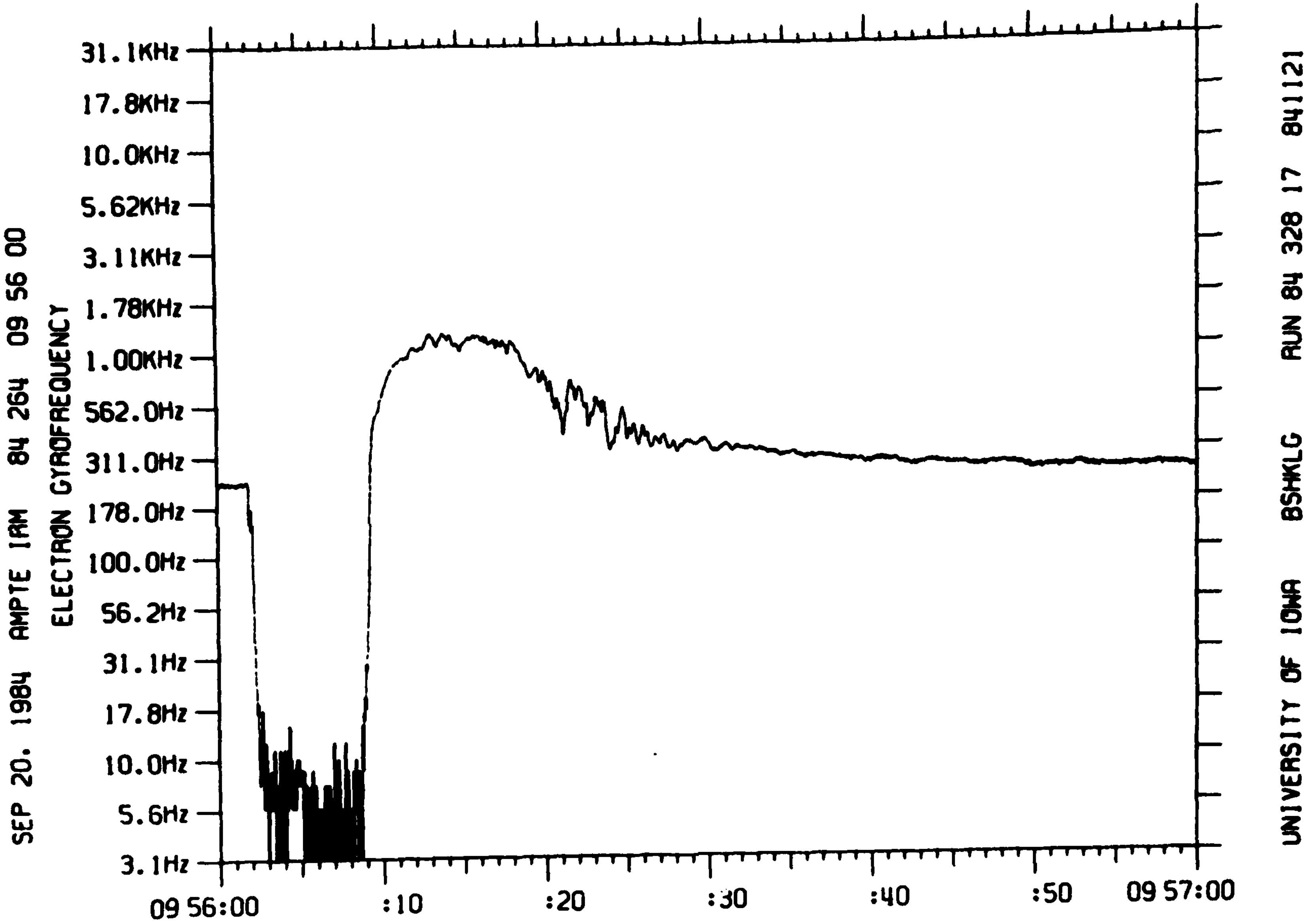
Figure 6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1.78KHz
1.00KHz
562.0Hz
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178.0Hz
100.0Hz
56.2Hz
31.1Hz
17.8Hz
10.0Hz
5.6Hz
3.1Hz
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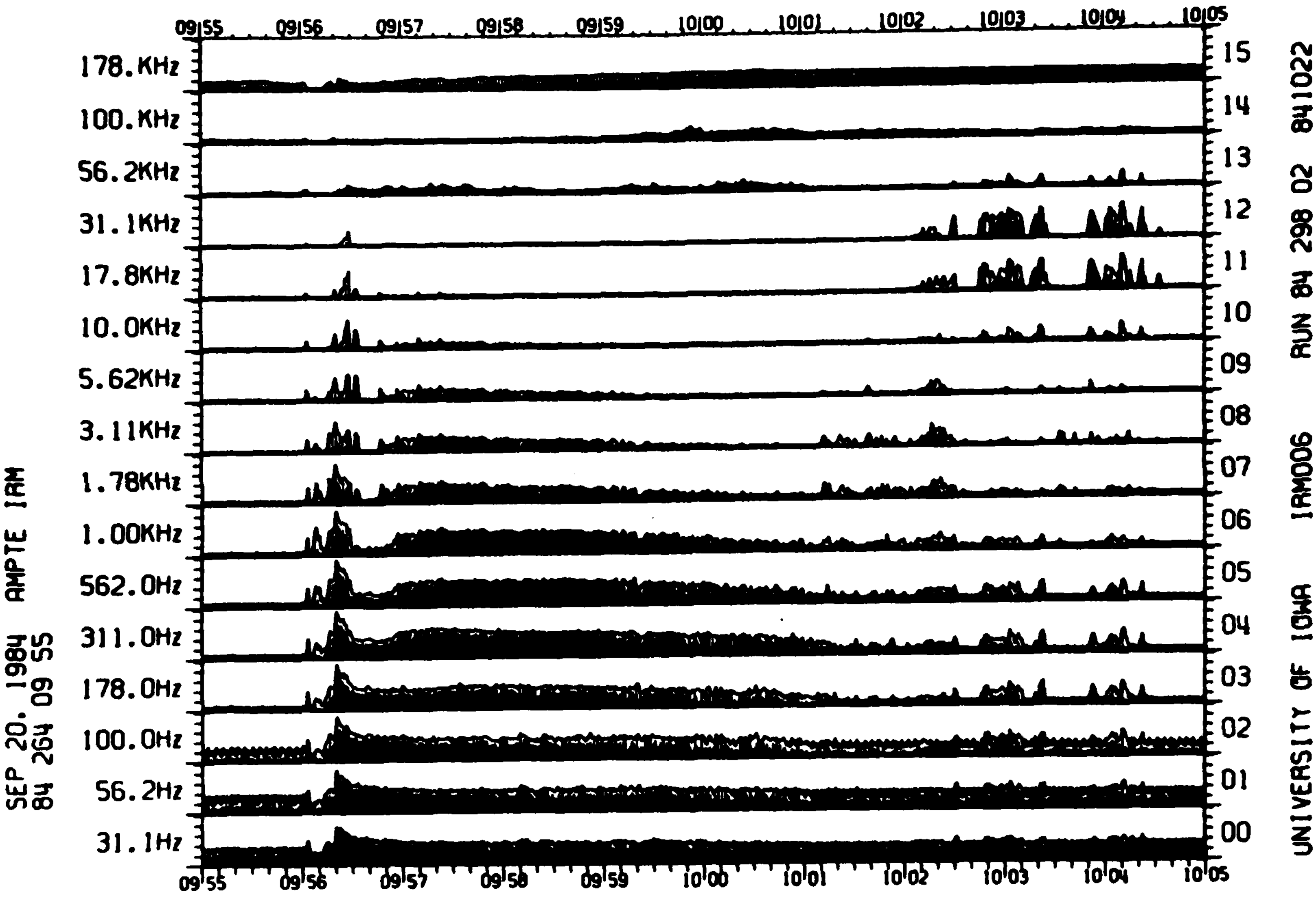
09 57:00
UNIVERSITY OF IOWA BSHKLG RUN 84 328 17 841121

Figure 7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1.78KHz
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31.1Hz
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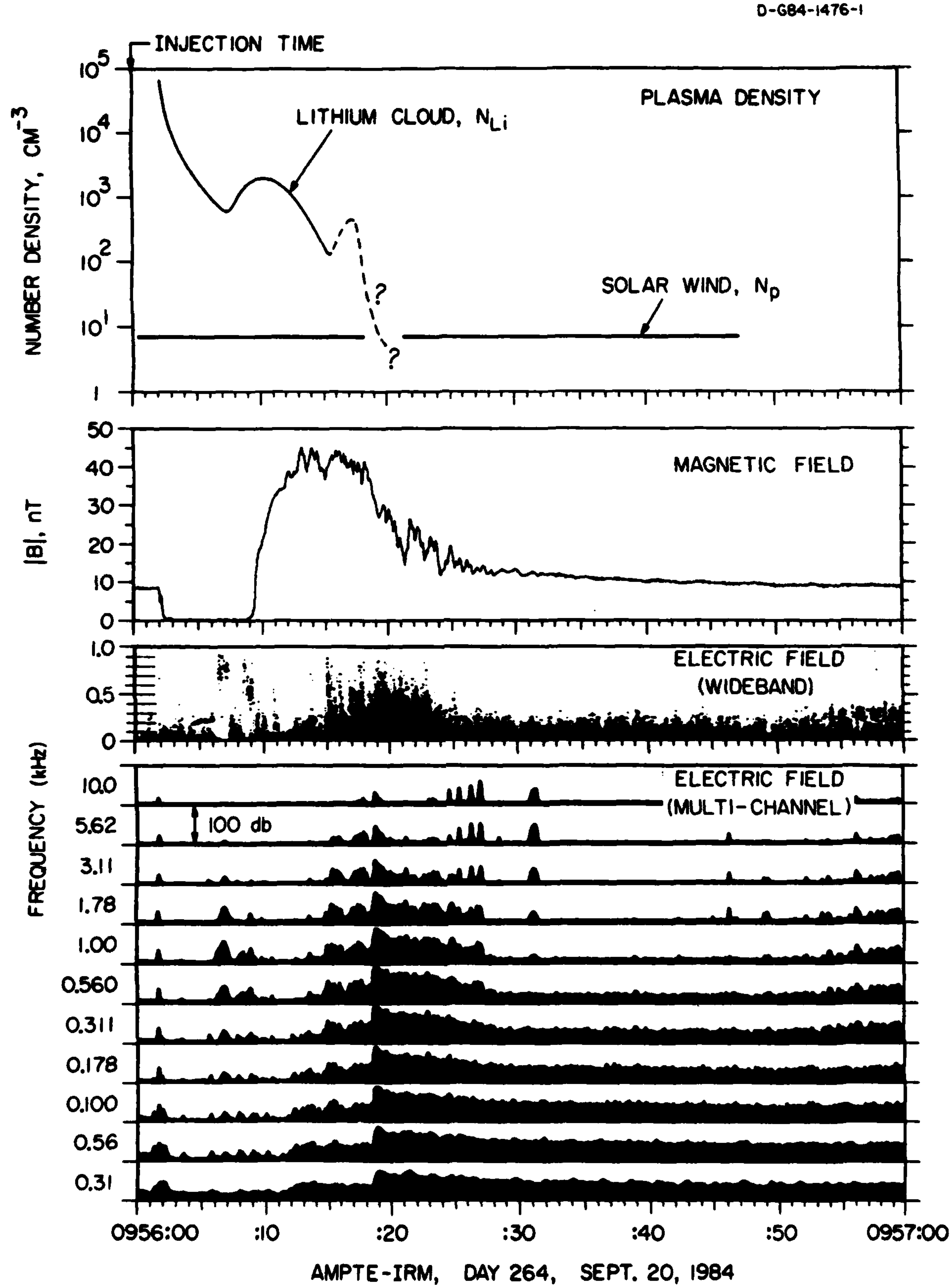
Figure 8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SOLAR WIND, N_p
NUMBER DENSITY, CM^{-3}
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|B|, nT
ELECTRIC FIELD
(WIDEBAND)
ELECTRIC FIELD
(MULTI-CHANNEL)
100 db
FREQUENCY (kHz)
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5.62
3.11
1.78
1.00
0.560
0.311
0.178
0.100
0.56
0.31
0956:00
:10
:20
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AMPTE-IRM, DAY 264, SEPT. 20, 1984

Figure 9